

Diffraction and high-energy features in three-dimensional photonic crystals

F. García-Santamaría¹, J. F. Galisteo-López², C. López², and P. V. Braun¹

¹Department of Materials Science and Engineering, Frederick Seitz Materials Research Laboratory and Beckman Institute, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801, USA

²Instituto de Ciencia de Materiales de Madrid, C/ Sor Juana Inés de la Cruz 3, 28049-Madrid, Spain

Diffraction phenomena in three-dimensional (3D) photonic crystals (Fig. 1) present a number of issues such as: surface or bulk effect; is the 2D grating equation sufficient; the symmetry the pattern should have; their impact on transmission and reflectance spectra.

Here we provide a band structure based interpretation of the diffraction observed in 3D photonic crystals. Qualitative and quantitative information about the patterns is obtained in a simple manner from the band structure. Our conclusions and experimental results explain phenomena occurring at frequencies above the first stop band that were previously not properly interpreted. Optical features observed in transmission spectra from opaline photonic crystals are now viewed under a new light by relating them to the diffraction phenomena. We also observe an intriguing change in the diffraction pattern symmetry when the photonic crystal dielectric contrast is modified (Fig. 1c).

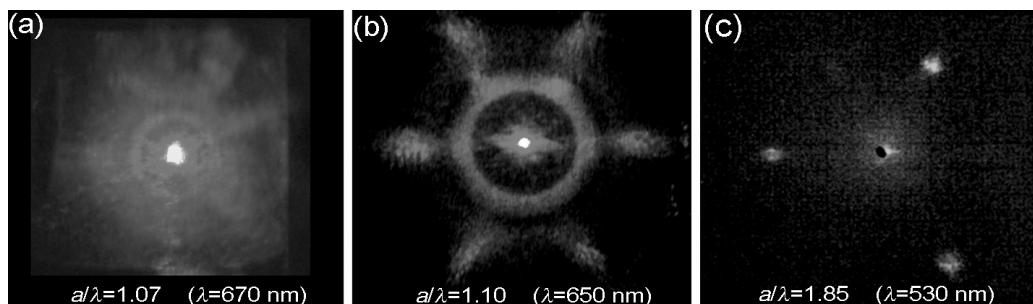


Figure 1. (a, b) Diffraction patterns from opals of 505 nm diameter polystyrene spheres in air. (c) Diffraction pattern from an opal of 695 nm polystyrene microspheres with 70% of the pore volume loaded with SiO₂.